WHAT IS CLAIMED IS:

1. A thermal barrier coating for an underlying metal substrate which comprises a zirconia-containing ceramic composition having a c/a ratio of the zirconia lattice in the range of from about 1.0117 to about 1.0148 and stabilized in the tetragonal phase by a stabilizing amount of a stabilizer metal oxide other than solely yttria, the thermal barrier coating having:
   1. a fraction of porosity of from about 0.10 to about 0.25; and
   2. an impact and erosion resistance property defined by at least one of the following formulas:
      (a) $I = \exp. [5.85 - (144 \times s) - (3.68 \times p)]$;
      (b) $E = [187 - (261 \times p) - (9989 \times s)]$;

   wherein $s = 1.0117 - c/a$ ratio; p is the fraction of porosity; I is at least about 140 g/mil; and E is at least about 130 g/mil.

2. The coating of claim 1 which has a strain-tolerant columnar structure.

3. The coating of claim 2 wherein the c/a ratio is in the range of from about 1.0117 to about 1.0137.

4. The coating of claim 2 wherein the fraction of porosity is from about 0.15 to about 0.20.

5. The coating of claim 2 which has an impact and erosion resistance property defined by both of formulas (a) and (b).

6. The coating of claim 5 wherein I is at least about 180 g/mil and E is at least about 140 g/mil.

7. The coating of claim 2 wherein the zirconia-containing ceramic composition comprises from about 91 to about 97 mole % zirconia and from about 3 to about 9 mole % stabilizer metal oxide selected from the group consisting of calcia, ceria, scandia, magnesia, india, lanthana, gadolinia, neodymia, samaria, dysprosia, erbia, ytterbia, europia, praseodymia, mixtures thereof, and combinations thereof with yttria.

8. The coating of claim 7 wherein the stabilizer metal oxide is selected from the group consisting of ytterbia, neodymia, mixtures thereof, and combinations thereof with yttria.

9. The coating of claim 8 wherein the zirconia-containing ceramic composition comprises from about 95 to about 97 mole % zirconia and from about 3 to about 5 mole % of a combination of ytterbia, neodymia or a mixture thereof with yttria.

10. A thermally protected article, which comprises:

A. a metal substrate; and

B. a thermal barrier coating which comprises a zirconia-containing ceramic composition having a c/a ratio of the zirconia lattice in the range of from about 1.0117 to about 1.0148 and stabilized in the tetragonal phase by a stabilizing amount of a stabilizer metal oxide other than solely yttria, the thermal barrier coating having:

1. a fraction of porosity of from about 0.10 to about 0.25; and

2. an impact and erosion resistance property defined by at least one of the following formulas:

(a) $I = \exp. [5.85 - (144 \times s) - (3.68 \times p)]$;

(b) $E = [187 - (261 \times p) - (9989 \times s)]$;

wherein $s = 1.0117 - c/a$ ratio; p is the fraction of porosity; I is least about 140 g/mil; and E is least about 130 g/mil.

11. The article of claim 10 which further comprises a bond coat layer adjacent to and overlaying the metal substrate and wherein the thermal barrier coating is adjacent to and overlies the bond coat layer.

12. The article of claim 11 wherein the thermal barrier coating has a thickness of from about 1 to about 100 mils.

13. The article of claim 12 wherein the thermal barrier coating has a strain-tolerant columnar structure.

14. The article of claim 13 wherein the c/a ratio is in the range of from about 1.0117 to about 1.0137.

15. The article of claim 13 wherein the fraction of porosity is from about 0.15 to about 0.20.

16. The article of claim 13 wherein the thermal barrier coating has an impact and erosion resistance property defined by both of formulas (a) and (b).

17. The article of claim 16 wherein I is at least about 180 g/mil and E is at least about 140 g/mil.

18. The article of claim 13 wherein the zirconia-containing ceramic composition comprises from about 91 to about 97 mole % zirconia and from about 3 to about 9 mole % stabilizer metal oxide selected from the group consisting of calcia, ceria, scandia, magnesia, india, lanthana, gadolinia, neodymia, samaria, dysprosia, erbia, ytterbia, europia, praseodymia, mixtures thereof, and combinations thereof with yttria.

19. The article of claim 18 wherein the stabilizer metal oxide is selected from the group consisting of ytterbia, neodymia, mixtures thereof, and combinations thereof with yttria.

20. The coating of claim 19 wherein the zirconia-containing ceramic composition comprises from about 95 to about 97 mole % zirconia and from about 3 to about 5 mole % of a combination of ytterbia, neodymia or a mixture thereof with yttria.

21. The article of claim 13 which is a turbine engine component.

22. The article of claim 21 which is a turbine shroud and wherein the thermal barrier coating has a thickness of from about 30 to about 70 mils.

23. The article of claim 21 which is a turbine airfoil and wherein the thermal barrier coating has a thickness of from about 3 to about 20 mils.

24. A method for preparing a thermal barrier coating for an underlying metal substrate, the method comprising the step of:

a. depositing over the metal substrate a zirconia-containing ceramic composition having a c/a ratio of the zirconia lattice in the range of from about 1.0117 to about 1.0148 and stabilized in the tetragonal phase by a stabilizing amount of a stabilizer metal oxide selected from the group consisting of calcia, ceria, scandia, magnesia, india, lanthana, gadolinia, neodymia, samaria, dysprosia, erbia, ytterbia, europia, praseodymia, mixtures thereof, and combinations thereof with yttria, to form a thermal barrier coating having:

1. a fraction of porosity of from about 0.10 to about 0.25; and
2. an impact and erosion resistance property defined by at least one of the following formulas::

(a) $I = \exp. [5.85 - (144 \times s) - (3.68 \times p)]$;

(b) $E = [187 - (261 \times p) - (9989 \times s)]$;

wherein $s = 1.0117 - c/a$ ratio; p is the fraction of porosity; I is least about 140 g/mil; and E is least about 130 g/mil.

25. The method of claim 24 wherein a bond coat layer is adjacent to and overlies the metal substrate and wherein the thermal barrier coating is formed on the bond coat layer.

26. The method of claim 25 wherein the zirconia-containing ceramic composition is deposited by physical vapor deposition to form a thermal barrier coating having a strain-tolerant columnar structure.

27. The method of claim 26 wherein the thermal barrier coating is formed so as to have an impact and erosion resistance property defined by both of formulas (a) and (b).

28. The method of claim 27 wherein the thermal barrier coating is formed to have an impact and erosion resistance property defined by formulas (a) and (b) such that I is at least about 180 g/mil and E is at least about 140 g/mil.

29. The method of claim 26 wherein the thermal barrier coating is formed from a zirconia-containing ceramic composition which comprises from about 91 to about 97

mole % zirconia and from about 3 to about 9 mole % of the stabilizer metal oxide.

30. The method of claim 29 wherein the thermal barrier coating is formed to have a fraction of porosity of from about 0.15 to about 0.20 and is formed from a zirconia-containing ceramic composition having a c/a ratio in the range of from 1.0117 to about 1.0137.